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METHOD AND DEVICE FOR CONNECTION AND ADJUSTMENT OF OPTICAL UNITS: ELEMENTS, MODULES, DEVICES, and SYSTEMS

Field of the Invention

The present invention relates to a method and a device for connection and adjustment of optical units (OA): elements, modules, devices and systems, in particular passive and/or active OA, aimed at controllable optimization of visual signals translation between the articles. The method and the device find application in optoelectronics, optomechanics, optical communications, instrument engineering, medical engineering, laboratory equipment, and all fields of technology using translation of visual signals between OU.

Prior Art

There is a device known for connection and adjustment of passive OU - optical fibres [1]. It is used to realize a method for the same purpose, according to which OU are arranged in pairs and fixed, one opposite the other in a frontal contact, to the respective carriers, one of the latter being movable. The two carriers with the OU are connected in a hermetically isolated from the environment optical channel with a guaranteed parallelism of the optical axes of the OU being optically connected through the channel. After that, the OU carriers are oriented in the space until the two OU get coaxial, i.e. until the necessary optimal translation of visual signals is achieved. Orientation is carried out by repeated,

iterative series of independent rectilinear stepwise shifts of the movable carrier in two inter-perpendicular planes, the latter being perpendicular to the axis of the carrier. Along with the carriers' orientation, the movable carrier is frontally tightened and locked to the immovable one, each following shift increasing the locking force. Meanwhile, running check is carried out with respect to the orientation precision and the degree of the optical channel mechanical links sealing.

The device consists of two rigid OU carriers; a rigid body, i.e. a hollow nut, axially connecting and embracing the carriers; a soft flexible ring, disposed between the faces of one of the carriers and the nut, pressing them one to the other and sealing the optical channel, the latter being formed by the three rigid bodies; two adjusting screws and a spring support, used for the rectilinear displacement and locking of the movable carrier.

A common shortcoming of the method and the device realizing it is that they allow only parallelism and coaxiality adjustment of the carriers, respectively of the OU optical axes.

A drawback of the method is the fact that its use is possible only upon preliminary and precise OU orientation for achieving guaranteed parallelism of their optical axes prior to fixing them to the carriers. This necessitates the use of complicated and expensive technology for the manufacture of the devices for the realization of the method.

A drawback of the device is the fact that its operational possibilities and reliability are limited, especially in cases of high temperatures and aggressiveness of the environment. Limitations are caused by the soft flexible ring having unstable mechanical characteristics, as well as by the

mechanical links in the device construction, which are not resistant to vibration and shaking.

There is a device known for OU connection and adjustment, i.e. a reflecting optical element (concave mirror) and an active optical element contained in a sealed optical channel [2]. It is used to realize a method, according to which the reflecting element is fixed to a movable carrier opposite to the optical axis of an immovable carrier, the active optical element being fixed to the latter, while both OU carriers are connected in a sealed optical channel with a guaranteed precision of intersection of the optical axes of the OU carried thereby. Then, the OU get inter-oriented in space, the movable carrier moving towards the immovable axis of the active optical element of the immovable carrier by means of iterative stepwise spatial angular shifts around the point of intersection of the two OU optical axes, with a permanent force of pressure of the carriers' contact surfaces. Along with the iterative angular shifts of the movable carrier, a running check is carried out of the precision of the carriers orientation, the shifts being carried out until the required optimal interposition is achieved of the optical axes of the OU carried thereby.

The device consists of rigid bodies only, i.e. two OU carriers and a third one that embraces and connects the carriers, the three bodies being connected so that they form a sealed optical channel. Auxiliary rigid and springy mechanical elements ensure the axial inter-pressure of the bodies, while for the iterative spatial and angular shifts of the movable carrier there are adjusting screws provided for.

A common drawback of the method and the device is their restricted applicability. They can be used only for

reflecting OU and for spatial and angular OU adjustment, for there are no ways and means provided for the connection and displacement of other OU, e.g. elements, modules, devices and systems, into directions perpendicular to the optical axis.

A shortcoming of the method is the fact that its realization necessitates the use of devices with a high technological precision of manufacture and assembly, such devices being able to guarantee preliminary technological precision of the OU optical ax intersection prior to their connection and following orientation.

A drawback of the device is its low operational reliability owing to the fact that its complicated construction is not resistant to vibrations and shocks.

Another drawback of the device is its narrow range of OU spatial adjustment owing to the small stroke of the adjusting screws used to effect the adjustment.

A device is known for OU connection and adjustment, i.e. fibres [3]. It is used to realize a method, according to which OU are arranged in pairs and fastened movably or immovably, at a distance one from the other, to the respective carriers, at least one of the latter being movable. Then, the two carriers with the OU fastened thereto are connected through a third, interstitial body, so that the three bodies form an optical channel isolated from the environment or communicating therewith, through which the carried OU get optically interconnected. The optical medium in the channel is homogeneous or heterogeneous as regards its composition and properties. The bodies forming the optical channel and carrying a certain pair of OU are angularly oriented in the space until the relative position is achieved necessary for the

optimal translation of visual signals, i.e. the position of coaxiality, or parallelism, or intersection, or crossing of the optical axes of the OU carried thereby. The bodies are oriented by means of interdependent repeated, iterative series of rectilinear stepwise shifts and locking of the movable OU carrier or carriers (where both carriers are movable). The shifts and locking are accompanied by a running check of the relative position of the OU optical axes. Each angular displacement of a body is preceded by a partial release from the locking, and is followed by a new, stronger locking and a check of the relative position of the bodies, respectively of the OU optical axes, for each partial release and new locking change, to a certain extent, the relative position of the OU carriers established so far. The iterative angular shifts of a movable OU carrier are carried out around a center of rotation, with variable space coordinates, towards the position of the same movable body.

Where the optical channel shaped by the three bodies, i.e. the two OU carriers and the interstitial body, has to be isolated from the environment, the last operation, i.e. the angular shift and the respective locking of the movable body, is followed by a final check as to whether the mechanical links between the bodies shaping the channel are sealed.

The device used to realize the method for OU connection and adjustment comprises at least three bodies, i.e. two end bodies and an interstitial one, for each adjusted OU pair. The bodies are connected and locked by means of screws, thus forming an optical channel with a homogeneous or heterogeneous medium, the channel being isolated from the environment or communicating therewith. At least two bodies

of each triad have opposite central through holes shaping the opening of the optical channel, the axis of the latter being rectilinear in the case of one triad, or angularly refracted or branched from a common point in the case of more than one triad of bodies with an immovable end body common for all triads. Each of the two end bodies of each triad has a bearing surface, either smooth or threaded, for the respective OU to be secured thereto. One of those bodies, which is immovable, represents a housing of the device having an attachment surface for external mounting of the device to a panel wall or to a part of an apparatus. The two OU secured to the carriers get locked, upon their optical communication, to the bodies at a certain distance one from the other, while their axes are angularly inter-oriented as a result of the shifts and locking of the carriers. These bodies are frontally or radially connected by the interstitial body, made of soft flexible material, by means of two kinds of screws, i.e. coupling/adjusting screws and locking screws. The screws are placed within the immovable carrier, respectively axially or transversally and radially to its axis, and are subjected to tension or compression. When orienting the OU carrier, the center of its angular displacement changes its position towards the body depending on the variable deformation of the interstitial body, caused by its screw tightening when displaced or locked. That center is disposed within the volume of one of the carriers or between the two end carriers or outside them, depending on the different embodiments of the invention. In the embodiments with an optical channel communicating with the surrounding, there is a transversal hole in the housing of the device for the channel communication.

A basic drawback of the method and the device realizing it is the fact that they allow a restricted spatial orientation of the carriers, i.e. only by means of angular shifts of the movable carrier/s. The method and device application is thus limited to cases of OU connection and adjustment for the purpose of optical beams communication and reflection in small angular ranges.

Still another shortcoming of the method and the device is the fact that the adjustment operational indexes achieved thereby are rather unsatisfactory, i.e.:

- low precision due to the restricted or just angular displacement of the movable body/s and the geometrical scattering of the deviations when positioning that body/s, caused by the variable position of the angular displacement center depending on the interstitial body deformation;

- low productivity caused by the great number of adjustment operations necessitated by the inconstant position of the angular displacement center of the movable body/s, as well as by the time separated operations for displacement and locking of the body/s.

A main drawback of the device is the fact that it has restricted functional possibilities, for it is fit for connection and adjustment of optical and optoelectronic elements only (fibres, reflectors), small angles being enough for the adjustment thereof, due to the limited spatial orientation of its carriers and the restricted possibilities for external mounting, i.e. by means of the end carrier only, for the interstitial one is flexible. The device is not fit for adjustment of optical articles whose optical axes require substantial angular deflections, for they use dispersing and double beam refracting optical

elements, such as prisms, diffraction gratings, Wollaston prisms, etc.

Still another drawback of the device is the fact that it has low performance indexes:

- narrow adjustment range owing to the soft flexible interstitial body, which gets deformed when tightened by screws and necessitates a small displacement stroke of the movable carrier;

- low precision of positioning of the movable carrier due to the soft flexible link between the carriers, which destabilizes the angular displacement center of the movable carrier and causes considerable dispersion of the movable carrier positioning deviation;

- low adjustment productivity due to the great number of time-consuming adjustment operations necessitated by the soft flexible link between the carriers, as well as by the use of two kinds of screws, i.e. coupling and adjusting screws and locking screws, which are necessary for the time-separated displacement and locking effected by identical iterative operations, the latter being accompanied by partial loosening of the movable carrier/s;

- low reliability, especially in the case of high temperature, moisture, shocks, vibrations, which necessitate more strict requirements as regards the optical channel sealing, said low reliability being caused by the soft flexible interstitial body having unstable mechanical characteristics, respectively changing in the course of time flexibility of the link between the bodies shaping the channel.

There are no method and device for OU connection and adjustment, able to ensure: reliable mechanical connection of

bodies carrying a wider range of OU, i.e. elements, modules, devices and systems; separate or combined optical communication, switching, branching, reflection, and damping of their directed or controlled optical beams, as well as efficient, i.e. wide-range, precise, highly productive spatial orientation of the connected OU for the purpose of achieving the required relative position thereof.

Technical Substance of the Invention

The method for OU connection and adjustment under the present invention consists in the following:

First, the OU to be connected and adjusted are arranged in pairs and fastened, either movably or immovably and at a distance one from the other, to carriers, at least one of the latter being movable. Then, the two carriers with the OU fastened thereto are connected with each other by an interstitial body so that the three bodies form an optical channel isolated from the environment or communicating therewith, the OU getting optically interconnected through the channel. The optical medium in the channel is either homogeneous or heterogeneous as regards its composition and properties. The bodies forming the optical channel and carrying a certain OU pair are spatially oriented , until the relative position necessary for the optimal translation of optical signals is achieved, i.e. position of coaxiality, parallelism, intersection or crossing of the optical axes of the OU carried thereby. Orientation of the bodies is carried out by repeated or iterative sequences of stepwise shifts and locking of the movable carrier or carriers with the OU (where the

movable carriers are two), accompanied by a running check of the relative position of the OU optical axes.

Besides, the iterative shifts of the carriers aimed at the spatial inter-orientation thereof are rectilinear and angular or angular and rectilinear. In the case of one movable and one immovable carrier, the orientation thereof is carried out by a series of iterative pairs of interdependent, consecutively alternating in each pair, rectilinear and angular, or angular and rectilinear shifts of the movable carrier, whereat the relative position of the OU axes, achieved by any rectilinear or angular shift of the body, gets partially changed by the next angular or rectilinear shift of the body. In the case of two movable carriers, the inter-orientation thereof is carried out by two consecutive series of mutually independent iterative shifts of each body, one of the series consisting of only rectilinear shifts of one of the bodies, while the second series consists of only angular shifts of the other body. In both cases, the rectilinear shifts of the movable carrier/s are performed perpendicularly to the axis of at least the interstitial body, the latter being movable or immovable (where the interstitial body and one of the carriers are coaxial, the shifts are perpendicular to the axis of the latter as well), while the angular shifts are effected around a permanent point on the axis of the angularly-shifted carrier. In both cases, locking of each movable carrier is carried out along with the respective shifts or only during each angular shift following a rectilinear shift of the body. Besides, in each following operation the locking force gets stronger until its optimal value is reached in the last locking. Where the optical channel formed by the three bodies, i.e. the two carriers and the interstitial body, has

to be isolated from the environment, the last operation, i.e. shift and respective locking of the movable body, is followed by a final check of the sealing of the mechanical links between the bodies forming the channel.

In order to effect the rectilinear shifts of the movable carrier (both in the cases of one or two movable bodies), the latter is acted upon along axes in a plane perpendicular to the axis of at least the interstitial body, either movable or immovable, while for performing of its angular shifts the movable carrier is acted upon along axes parallel to its axis or to the axis of the interstitial body.

According to the invention, the device for realizing the method of OU connection and adjustment comprises at least one triad of two end OU carriers and one interstitial body for each pair of OU being connected and adjusted. The bodies are connected and locked by screws, thus shaping an optical channel isolated from the environment or communicating therewith. At least two bodies of each triad have opposite central through holes that shape the opening of the optical channel, the latter having optical medium which is homogeneous or heterogeneous as regards its composition and properties. The optical channel axis is rectilinear in the case of one triad of bodies, or angularly refracted or branched from a common point in the case of more than one triad of bodies having an immovable body common for all triads. The two end bodies of each triad have a bearing surface for the respective OU to be fastened thereto, and one of the three bodies is immovable and represents the housing of the device having a contact surface for external mounting of the device to the wall of a panel, apparatus, etc.

Besides, the three bodies of each triad are rigid, one of the end bodies and the interstitial body being axially connected through a spatial or plain hinge, while the second end body and the interstitial one are frontally connected in a common slip plane transverse to the axes thereof. The hinge contact surfaces represent either a part of a concave sphere and a right circular cylinder base, or a part of a concave cylindrical surface and a parallelepiped or a cube base, or a part of a concave ellipsoid and an elliptic cylinder base. Each of the concave contact surfaces of the hinge has either a center on the symmetry axis of the body hinged therein, or a central axis crossing the said symmetry axis. The center and the central axis of the respective concave contact surfaces of the hinge are disposed either between the bodies hinged therein, or within the volume of one of the end bodies, or outside the three bodies. The interstitial body and the second end body, frontally connected in the said slip plane, have each a front contact surface transverse to the axes thereof. The screws for connection of the bodies are locking at the same time, where the connected bodies are movable, i.e. shifting when effecting the adjustment of the OU carried thereby. The coupling and locking screws, some of which can be replaced by functionally equivalent bearing spring elements, are placed within one or two of the triads of bodies arranged in two groups according to the purpose they are intended for, i.e. for effecting rectilinear or angular adjustment shifts of the movable body. A group of the screws are subjected to compression and are disposed along axes perpendicular to the interstitial body axis, as well as to the axis of the end carrier frontally connected therewith. The other group of screws are

either subjected to compression and disposed along axes parallel to the axis of the carrier they are placed in, the carrier being hinged to the interstitial body, or subjected to tension and disposed along axes parallel to the axis of the body they are placed in and to the interstitial body as well. The two groups may comprise the same or different number of screws. The axes of the two groups of coupling and locking screws are intercrossing and/or perpendicularly intersecting.

Where the interstitial body represents the housing of the device, in addition to the contact surface for external mounting of the device it has also a bearing surface for an additional OA, which is disposed either between the two OU being interconnected and adjusted, or outside them.

The interstitial body may consist of axially connected movable and one immovable parts, the immovable part representing the device housing.

The contact surface for external mounting of the device represents a plane or a rotational surface of the respective immovable end or interstitial body representing the housing of the device.

According to an embodiment of the device, the transversally slipping interstitial body touches laterally a spring element/s disposed opposite coupling and locking screws, the latter being carried by the end OU carrier contacting with the interstitial body in a slip plane.

In some of the embodiments of the device, the contact surfaces of the hinged bodies and the contact planes of the bodies frontally connected in a slip plane are tightened by the coupling and locking screws for angular shifts of the movable body/s. In other embodiments of the device, it is only the

contact surfaces of the hinged bodies that are tightened by the said screws, while the contact surfaces of the frontally slipped bodies are tightened into a constant, close fit in guides.

In all embodiments of the device, the coupling and locking screws for angular shifts of the movable carrier/s are placed along the axis of the optical channel of the device. In some of the device embodiments, the screws tighten together the three bodies of each triad. In other embodiments thereof, the same screws tighten the three bodies into pairs, the latter having a common body, i.e. the interstitial one, and an end carrier each.

The advantages of the method and the device for OU connection and adjustment, according to the invention, consist in the following:

1. The combination of operations according to the method, as well as the technological order and requirements concerning the execution thereof, allow to perform a wide-range, overall spatial adjustment of the relative position of the optically connected OA, as well as to make a universal device for separate or combined optical connection, switching, branching, reflection, attenuation of directed or controlled optical beams in an optical channel, the latter being isolated from or communicating with the environment. The method and the device realizing it ensure fine, repeated or iterative, spatial , combined, i.e. angular and transversal rectilinear orientation of coaxiality, or parallelism, or intersection, or crossing of the axes of the oppositely fastened OA, with a random initial position of the carriers in the space.

2. The method and the device ensure efficient adjustment of the optically connected OU with high operational indexes, such as:

• high precision, including in the case of a wide range of shifts of the movable body/s, owing to the combined spatial orientation thereof by angular and transversal rectilinear shifts, instead of only angular or only transversal rectilinear ones, as well as to the reduced geometrical scattering of the positioning deviations upon each angular shift around a center or an axis with constant coordinates on the axis of the angularly shifted carrier.

• flexible choice of the kind of adjustment, i.e. either combined, meaning angular and rectilinear, or separate, meaning only angular or only rectilinear.

• high productivity owing to the reduced number of adjustment operations, this being possible thanks to the permanent position of the center or the axis of the angular shift; owing also to the time coincidence of the movable body shift and locking operations; and owing also to the use of interdependent iterative pairs of shift and locking operations in the case of one movable OU carrier.

3. The device has a universal construction permitting an overall and precise spatial combined orientation by means of an angular and a rectilinear transversal displacement of one of the movable end OU carriers or of the two movable end OU carriers, as well as the locking thereof. The construction ensures also universal mounting of different kinds of OA, i.e. elements (passive or active), modules, devices and systems, as well as external mounting, the rigid interstitial body included, to a wall or a seat. The construction being universal makes it

possible to manufacture multifunctional optical devices, such as couplers, switches, splitters, reflectors, attenuators, combined articles used in optical signal transmission lines, either as a part of optomechanical devices and systems, or independently as a case, fine positioner, or holder of bulk optical devices.

4. The device ensures high productivity, i.e. high operational characteristics of adjustment, including inter-orientation and locking of the OU carriers, e.g.:

- high precision of positioning of the bodies, including a wide adjustment range, the latter being possible due to the screw adjustment and the rigid construction links. It is ensured by the simple, manufacturable construction of the device, consisting of only rigid end and interstitial bodies, a spatial hinged and a radial slipping kinematic links, that stabilize the construction and ensure a permanent position of the center or the axis for angular displacement and, respectively, minimum deviation dispersion when positioning the movable body;

- high reliability, including in the case of pressing sealing requirements, high temperatures, humidity, shocks or vibrations. Such reliability is achieved by using the rigid interstitial body, by the sealing between rigid bodies, as well as by the said kinematic links ensuring mechanical stability of the construction for a longer period of operation;

- high adjustment productivity due to the shorter time necessary to perform the adjustment operations, due to:

(a) the smaller number of iterative shifts in the case of combined, i.e. angular and transversal rectilinear adjustment as compared to the separate adjustment, said

smaller number determining the permanent position of the angular displacement center/axis, resulting in reduction of the positioning time dispersion, as well as the performance of dependent combined adjustments owing to the overall construction;

(b) the time coincident shifts and locking of the OU carriers, effected by the same coupling and locking screws fitting the kind of adjustment shifts of the bodies;

(c) the lack of operations loosening the link between the bodies prior to each displacement of the movable body;

(d) the convenient handling owing to the smaller number of screws, which are combined, i.e. both coupling and locking, instead of being separate, i.e. coupling/ adjusting and locking, as well as to their position facilitating the attendance thereof.

Description of the Figures Enclosed

Figures 1, 2, 3, 4, 5, 6, 7, 8, 9 and 10 represent lengthwise sections of embodiments of the device according to the invention, comprising OA, such as collimators and/or focusing systems, the embodiments being intended for external mounting of the device to a plane, a coupling socket, etc.

Figure 1 illustrates an OU connector fastened, when mounting the device, along the flange neck of one of its carriers.

Figure 2 illustrates an OU connector intended for mounting to an apparatus or a panel wall by fastening along a flange face of one of its carriers.

Figure 3 shows an OU connector, intended for fastening, along two flange faces of the two carriers, to an apparatus or a panel wall.

Figure 4 shows an OU connector with a flexible hard body, i.e. a spring, sidewise to the interstitial body, the connector being intended for mounting to a wall along a flange face of one of its carriers.

Figure 5 illustrates an OU connector, intended for sidewise radial mounting through fastening of one of its carriers to the seat of an apparatus or a panel.

Figure 6 shows a reflecting optical attenuator for sidewise mounting of an end body to an apparatus seat.

Figure 7 illustrates a series switch with a cylindrical lens for a side assembly of an interstitial body to an apparatus seat or console.

Figure 8 illustrates a universal variant of a deflector, or a modulator, or an amplifier/attenuator, or a polarizer, depending on the optical properties of the body (substance) partitioning the optical axis, which is intended for mounting the bottom flat of its interstitial body to an apparatus seat or console.

Figure 9 shows a multi-channel switch of collimated beams with a beamlike optical channel, used for mounting the bottom flat of an end OU carrier, common for all triads of bodies, to a panel or a holder.

Figure 10 illustrates a rotational reflecting switch for mounting of the immovable part of the interstitial body to a panel or a holder.

Embodiments of the invention

A first embodiment of the device for connection and adjustment of OA, i.e. elements, modules, devices and systems, according to the invention, is illustrated in Figure 1. Here, the device comprises a triad of two end OU carriers 1, 2 and an interstitial body 3, coupled and locked by means of screws 4, 5, thus forming an optical channel with a homogeneous optical medium, the channel being isolated from or communicating with the environment. The three bodies 1, 2, 3 have confronting central through holes shaping the opening of the optical channel. The channel axis is rectilinear. The two end bodies 1, 2 have bearing surfaces for securing of the respective OA, upon the axial adjustment thereof, at a specified distance, the body 1 having a threaded surface 6 and a smooth guiding surface 6' for one of the OA, while the body 2 has only a threaded surface 6 for the other OA. The end body 1 is made of two parts, i.e. a flange with a neck 1' and a hinged member 1". Each of the end bodies 1 or 2 may be fixed, as a housing of the device, to an apparatus seat or a panel by means of its rotational 7 or flat 7' attachment surface.

The three bodies 1, 2, 3 are hard, the assembled end body 1 being axially connected to the interstitial body 3 by a spatial or a plain hinge, while the end body 2 and the interstitial body 3 are frontally connected in a common slip

plane transversal to the axes thereof. Besides, the contact surfaces of the hinge are either a part of a concave sphere 8 and a base of a right circular cylinder 9, or a part of a concave cylinder 10 and a base of a parallelepiped 11 or a cube 12, or a part of a concave ellipsoid 13 and a base of an elliptic cylinder 14. Each of the concave contact surfaces 8, 10, 13 of the hinge belongs to the body 1 and has a center 0 on the symmetry axis of the hinged body 3, or has a central axis 0'-0' crossing the said symmetry axis. The center 0 and the central axis 0'-0' of the respective concave contact surfaces 8, 10, 13 of the respective hinge are disposed within the volume of the non-connected hinge end body 2. The end body 2 and the interstitial body 3, frontally connected in the slip plane, have each a contact surface 15 transversal to their axes. Each movable body 1 or 2 or 3 of the triad is connected to the next one and locked, when effecting OU adjustment, by the same coupling and adjustment screws 4 for rectilinear shifts or 5 for angular shifts of the body. The said screws 4, 5 are arranged in groups, the number of screws being the same or different, and are placed in the end body 2 that is not hinged, the screws 4 of the group for rectilinear shifts of the body being subjected to compression, while the screws 5 of the group for angular shifts of the body are subjected to tension. The screws 4 of the first group are disposed along axes perpendicular to the axes of both the interstitial body 3 and the frontally connected therewith OU carrier 2, while the screws 5 of the other group are disposed along axes parallel to the axes of both the interstitial body 3 and the end body 2 they are placed in. Besides, the axes of the screws 4 and 5 of the two groups are, in pairs, intercrossing and/or perpendicularly intersecting.

The device section in Fig. 1 does not contain any indication of the complete number of screws of the two groups 4 and 5, but just a pair thereof. Where the contact surfaces of the hinge are a part of a concave sphere 8 and a base of a right circular cylinder 9, or a part of a concave ellipsoid 13 and a base of an elliptic cylinder 14, the axial tightening of all contacting surfaces of the bodies 1, 2, 3 by means of the coupling and locking screws 5, 4 results, at the end of the OU adjustment, in the specified isolation (sealing) of the optical channel. In the other two variants of combinations of the hinged contact surfaces, the optical channel remains in a sidewise communication with the environment, if no sidewise sealing is provided for. According to the embodiment in Fig. 1, all axially connected surfaces of the neighbouring bodies in the hinge and in the front slip plane are tightened together by the screws 5 for angular shifts of the assembled end body 1 and the interstitial body ~~2~~ 3 when movable. That link between the bodies 1, 2, 3 renders the rectilinear and the angular shifts interdependent. The coupling and locking screws 4, 5 are adjusting as well, i.e. they are used for the overall adjustment of the device by means of a series of stepwise tightening of the screws 4, 5 leading respectively to the angular or transversal rectilinear replacement of the movable bodies 1, 3 or 2, 3, along with the replacement the three bodies 1, 2, 3 being locked to each other with an increasing strength, until achieving the relative position of the axes of the OU carried by the end bodies with the necessary degree of sealing or communication of the optical channel with respect to the environment.

A second embodiment of the device according to the invention is shown in Fig. 2. Here, the device comprises a triad of two end OU carriers 1, 2 and one interstitial body 3, the three bodies being connected and locked by screws 4, 5, thus forming an optical channel, which is isolated from or communicating with the environment. The three bodies 1, 2, 3 have confronting central through holes that shape the opening of the optical channel. The axis of said channel is rectilinear. The end body 1 is flat, while the end body 2 represents a flange with a neck. The flat end body 1 has a smooth attachment surface 6' for securing of the OU and an external face 7'. The body 2 has a threaded surface 6 and a smooth guiding surface 6', both surfaces serving to adjust the axial distance between the two connected OA. The end body 2 is made of a main flange part 2' and a hinged member 2". The device is intended for mounting through an attachment flat face 7' of the flat end body 1 to an apparatus wall or a panel. The body 1 represents a housing of the device. The three bodies 1, 2, 3 are hard, the assembled end body 2 being axially connected through a spatial or a plain hinge to the interstitial body 3, while the end body 1 and the interstitial body 3 are frontally connected in a common slip plane transversal to their axes. Besides, the contact surfaces of the hinge are either a part of a concave sphere 8 and a base of a right circular cylinder 9, or a part of a concave cylinder 10 and a base of a parallelepiped 11 or a cube 12, or a part of a concave ellipsoid 13 and a base of an elliptic cylinder 14. Each of the concave contact surfaces 8, 10, 13 of the hinge belongs to the interstitial body 3 and has a center 0 on the symmetry axis of the body 2 hinged therein, or has a central

axis 0'-0' crossing the said symmetry axis. The center 0 and the central axis 0'-0' of the respective concave contact surface 8, 10, 13 of the respective hinge are disposed within the volume of the hinged end body 2, while the end body 1 and the interstitial body 3, frontally connected in the slip plane, have a contact plane 15 each that is transversal to their axes. Each movable body 2, 3 of the triad is connected to the neighbouring body and locked, when adjusting the OA, by the same coupling and locking screws 4, 5 fitting the kind of the body shifts. The said screws 4, 5 are arranged in groups, the number of screws being the same or different, and are placed in the end body 1, whereat the screws 4 of the group for transversal rectilinear shifts of the movable body are subjected to compression, while the screws 5 of the group for angular shifts of the body are subjected to tension. The screws 4 of the first group are disposed along axes perpendicular to the axes of both the interstitial body 3 and the end carrier 1 frontally connected therewith, while the screws 5 of the other group are disposed along axes parallel to the axes of both the interstitial body 3 and the end body 1 they are placed in. Besides, the axes of the screws 4, 5 of the two groups are, in pairs, intercrossing and/or perpendicularly intersecting. The embodiment in Fig. 2 does not contain any indication of the full number of screws 4, 5 of the two groups, but just a pair thereof. The coupling and locking screws 4, 5 are adjusting at the same time. The results of the axial tightening of all contacting surfaces as shown in Fig. 2, respectively the sealing of the optical channel, as well as those of the overall adjustment of the device by a series of stepwise tightening of

said screws 4, 5 coincide with the results as indicated in the embodiment shown in Fig. 1.

The three bodies 1, 2, 3 are axially tightened together by the screws 5 for angular shifts of the movable body 2.

A third embodiment, according to the invention, is shown in Fig. 3. Here, the device comprises a triad of two end OU carriers 1, 2 and one interstitial body 3, connected and locked through screws 4, 5, thus forming an optical channel, the latter being isolated from or communication with the environment. The three bodies 1, 2, 3 have opposite central through holes shaping the opening of the optical channel. The axis of the channel is rectilinear. The end body 1 is flat, while the end body 2 is made of two parts assembled through a screw thread, i.e. a flat flange 2' and a hollow neck with a flange 2" passing through the through holes of the flat end body 1 and the interstitial body 3. The flat end body 1 has also a smooth attachment surface 6' of its through hole and an external face 7', respectively for OU securing and for mounting of the device to an apparatus wall or a panel. The end body 2 has a smooth attachment surface 6' for OU securing, as well as a screw link for adjustment of the axial distance between the two OA. The device is intended for mounting to an apparatus wall or a panel by means of the attachment front surface 7' of the immovable end body 1. The body 1 represents a housing of the device. The three bodies 1, 2, 3 are hard, the assembled end body 2 being axially connected to the interstitial body 3 by means of a spatial or plain hinge, while the end body 1 and the interstitial body 3 are frontally connected in a common slip plane transverse to their axes. Besides, the hinge contact surfaces are either a part

triad: a group of 3

of a concave sphere 8 and a base of a right circular cylinder 9, or a part of a concave cylinder 10 and a base of a parallelepiped 11 or a cube 12, or a part of a concave ellipsoid 13 and a base of an elliptic cylinder 14. Each of the concave contact surfaces 8, 10, 13 of the hinge belongs to the interstitial body 3 and has a center 0 on the symmetry axis of the end body 2 placed therein, or a central axis 0'-0' crossing the said symmetry axis. The center 0 and the central axis 0'-0' of the respective hinge are disposed outside the volume of the three bodies 1, 2, 3, while the end body 1 and the interstitial body 3, frontally connected in the slip plane, have each a contact plane 15 transverse to their axes. Each movable body 2, 3 of the triad is connected to the neighbouring body and locked, when effecting OU adjustment, by the same coupling and locking screws 4, 5 fitting the kind of the shifts thereof. The screws 4, 5 are arranged in groups, the number of screws being the same or different, and are placed as follows: the transversal rectilinear shifts group is placed in the end body 1, while the angular shifts group is situated in the end body 2. All screws 4, 5 are subjected to compression. The screws 4 of the first group are disposed along axes perpendicular to the axes of both the interstitial body 3 and the end body 1 frontally connected therewith, while the screws 5 of the second group are disposed along axes parallel only to the axis of the assembled end body 2 they are placed in. Besides, the axes of the screws 4,5 of the two groups are, in pairs, mutually crossing and/or perpendicularly intersecting. The embodiment in Fig. 3 contains no indication of the full number of screws 4 and 5, but just a pair thereof. The coupling and locking screws 4, 5 are adjusting as well. The

results of the axial tightening of all contacting surfaces as shown in Fig. 3, respectively the sealing of the optical channel, as well as those of the overall adjustment of the device by the number of stepwise tightening of the screws 4 and 5, coincide with the results according to the embodiment in Fig. 1. The three bodies 1, 2, 3 are axially tightened together by the screws 5 for angular shifts of the movable bodies.

A fourth embodiment of the device according to the invention is shown in Fig. 4. Here, the device comprises a triad of two end OU carriers 1, 2 and an interstitial body 3, the three bodies being connected and locked by screws 4, 5, thus forming an optical channel that is isolated from or communicating with the environment. The three bodies 1, 2, 3 have opposite central through holes shaping the opening of the optical channel. The axis of said channel is rectilinear. The end body 1 is flat, while the end body 2 is made of two parts, i.e. a flange 2 with a neck 2' and a hinged member 2". The flat end body 1 has a smooth attachment surface 6' for securing the OA, and an external face 7' for mounting the device to an apparatus wall or a panel. The assembled body 2 has a threaded surface 6 and a smooth guiding surface 6' for adjustment of the axial distance between the two OU being connected. The three bodies 1, 2, 3 are hard, the assembled end body 2 being axially connected to the interstitial body 3 by a spatial or plain hinge, while the end body 1 and the interstitial body 3 are frontally connected in a common slip plane transversal to the axes thereof. Besides, the contact surfaces of the hinge are either a part of a concave sphere 8 and a base of a right circular cylinder 9, or a part of a concave

cylinder 10 and a base of a parallelepiped 11 or a cube 12, or a part of a concave ellipsoid 13 and a base of an elliptic cylinder 14. Each of the concave contact surfaces 8, 10, 13 of the hinge, belonging to the assembled end body 2, has a center 0 on the symmetry axis of the body 2 hinged therein, or a central axis 0'-0' crossing the said symmetry axis. The center 0 and the central axis 0'-0' of the respective concave contact surfaces 8, 10, 13 of the respective hinge are situated within the volume of the interstitial body 3. The assembled end body 2 and the interstitial body 3, frontally connected in the slip plane, have each a contact surface 15 transversal to their axes. Each movable body 2, 3 of the triad is connected to the neighbouring body and locked, when performing OU adjustment, by means of coupling and locking screws 4, 5 fitting the kind of the shifts. The screws 4, 5 are arranged in groups in the end body 2, the number of screws being the same or different, whereat the screws 4 of the group for transversal rectilinear shifts of the body are subjected to compression, while the screws 5 of the group for angular shifts of the body are subjected to tension. The screws 4 of the first group are disposed along axes perpendicular to the axes of both the interstitial body 3 and the end body 1 frontally connected therewith, while the screws 5 of the second group are situated along axes parallel to the axes of both the interstitial body 3 and the end body 1 they are placed in. Besides, the axes of the screws 4, 5 are, in pairs, mutually crossing and/or perpendicularly intersecting. The embodiment in Fig. 4 does not contain any indication of the full number of the screws 4 and 5, but just a pair thereof. The coupling and locking screws 4, 5 are adjusting as well. A part of the screws

4 for transversal rectilinear displacement of the body may be replaced by support spring members 18 that are equivalent to the screws 4 as regards their action. When tightening the angular adjustment screws 5, only the hinge contact surfaces 8 and 9 or 10 and 11/12 or 13 and 14 remain tightened, while the contact surfaces 15 of the bodies in the plane of the frontal slipping thereof remain in a permanent force fit within guides 17.

A fifth embodiment of the device, according to the invention, is illustrated in Fig. 5. Here, the device comprises a triad of two end OU carriers 1, 2 and an interstitial body 3, connected and locked by screws 4 and 5, thus forming an optical channel, which is isolated from or communicating with the environment. The three bodies 1, 2, 3 have opposite central through holes shaping the opening of the optical channel. The axis of the channel is rectilinear. The end body 1 is cup-shaped and embraces the bodies 2 and 3, while the end body 2 represents a flange with a neck. The embracing end body 1 is made of two parts, i.e. a main part 1' and a flange 1" connected by a thread, ring-likely embracing the cup-shaped back face of the end body 2. The embracing end body 1 has an attachment threaded surface 6 for OU securing and external attachment surfaces 7 and 7' for mounting to an apparatus seat or a panel. The end body 2 has a smooth attachment surface 6' for OU securing. The three bodies 1, 2, 3 are hard, the end body 2 being axially connected to the interstitial body 3 by a spatial or plain hinge, while the end body 1 and the interstitial body 3 are frontally connected in a common slip plane transverse to the axes thereof. Besides, the hinge contact surfaces are either a part of a concave sphere 8 and a base of

a right circular cylinder 9, or a part of a concave cylinder 10 and a base of a parallelepiped 11 or a cube 12, or a part of a concave ellipsoid 13 and a base of an elliptic cylinder 14. Each of the concave contact surfaces 8, 10, 13 of the hinge belongs to the embraced end body 2 and has a center 0 on the symmetry axis of the body 3 hinged therein, or has a central axis 0'-0' crossing the said symmetry axis. The center 0 and the central axis 0'-0' of the respective concave contact surfaces 8, 10, 13 of the respective hinge are situated within the assembled hinge interstitial body 3, respectively within the volume of the end body 1 embracing it, while the embracing end body 1 and the interstitial body 3, frontally connected in the slip plane, have each a contact plane 15 transversal to the axes thereof. Each movable body 2, 3 of the triad is connected to the neighbouring body and locked, when effecting OU adjustment, by the same coupling and locking screws 4, 5 fitting the kind of the body replacement. The screws 4, 5 are arranged in groups in the end body 1, the number of screws being the same or different, whereat all screws 4, 5 of the two groups are subjected to compression. The screws 4 are disposed along axes perpendicular to the axes of both the interstitial body 3 and the embracing end body 1 bearing the screws. The screws 5 are disposed along axes parallel to the axes of both the interstitial body 3 and the end body 2 bearing the screws. Besides, the axes of the screws 4, 5 are, in pairs, mutually crossing and/or perpendicularly intersecting. The embodiment in Fig. 5 contains no indication as to the full number of screws 4, 5, but just a pair thereof. The coupling and locking screws 4, 5 are adjusting as well. The results of the axial tightening of all contact surfaces as indicated in Fig.

5, respectively the sealing of the optical channel, as well as those of the overall adjustment of the device by a number of stepwise tightening of the screws 4 and 5, coincide with the results according to the embodiment in Fig. 1. The three bodies 1, 2, 3 are axially tightened together by the screws 5 for angular displacement of the movable bodies.

A sixth embodiment of the device according to the invention is shown in Fig. 6. Here, the device comprises a triad of two end OU carriers 1, 2 and one interstitial body 3, the three bodies being connected and locked by coupling and locking screws 4 and 5, thus forming an optical channel, which is isolated from or communicating with the environment. The three bodies 1, 2, 3 have opposite central through holes shaping the opening of the optical channel. The axis of the said channel is rectilinear. The end body 1 is dense, either rotational or non-rotational, while the end body 2 represents a flange with a neck. The dense end body 1 has a threaded attachment surface 6 for OU securing and adjustment of the axial distance between the OU connecting bodies, as well as a smooth external attachment surface 7 for mounting to an apparatus seat and a surface 7' for mounting to a table or console. The end body 2 has a smooth attachment surface 6' for OU securing. The three bodies 1, 2, 3 are hard, the end body 2 being axially connected to the interstitial body 3 by a spatial or plain hinge, while the end body 1 and the interstitial body 3 are frontally connected in a common slip plane transversal to the axes thereof. Besides, the hinge contact surfaces are either a part of a concave sphere 8 and a base of a right circular cylinder 9, or a part of a concave cylinder 10 and a base of a parallelepiped 11 or a cube 12, or a part of a

concave ellipsoid 13 and a base of an elliptic cylinder 14. Each of the concave contact surfaces 8, 10, 13 of the hinge belongs to the end body 1 and has a center 0 on the symmetry axis of the interstitial body 3 hinged therein or a central axis 0'-0' crossing the said symmetry axis. The center 0 and the central axis 0'-0' of the respective concave contact surfaces 8, 10, 13 of the hinge are disposed within the volume of the interstitial body 3, respectively within the end body 1, while the end body 1 and the interstitial body 3, frontally connected in the slip plane, have each a contact plane 15 transversal to the axes thereof. Each movable body 2, 3 of the triad is connected to the neighbouring body and locked, when effecting OU adjustment, by the same coupling and locking screws 4, 5 depending on the kind of the body replacement, i.e. screws 4 for transversal rectilinear displacement and screws 5 for angular displacement. The screws 4, 5 are situated in groups in the end body 1, the number of screws being the same or different, whereat the screws 4 are subjected to compression, and the screws 5 are subjected to tension. The screws 4 are disposed along axes parallel to the axes of both the interstitial body 3 and the end body 1 they are placed in. Besides, the axes of the screws 4 and 5, in pairs, are mutually crossing and/or perpendicularly intersecting. The embodiment in Fig. 6 does not indicate the full number of the screws 4 and 5, but just a pair thereof. The coupling and locking screws 4, 5 are adjusting at the same time. The results of the axial tightening of all contact surfaces as indicated in Fig. 6, respectively the sealing of the optical channel, as well as the results of the overall adjustment of the device by a series of stepwise tightening of the said screws 4, 5 are the

same as the results according to the embodiment of Fig. 1. The three bodies 1, 2, 3 are tightened together by the screws 5 for angular displacement of the movable bodies.

A seventh embodiment of the device according to the invention is shown in Fig. 7. Here, the device comprises a triad of two end OU carriers 1, 2 and one interstitial body 3, connected and locked by coupling and locking screws 4 and 5, thus forming an optical channel, which is isolated from or communicating with the environment. The three bodies 1, 2, 3 have opposite central through holes shaping the opening of the optical channel. The axis of the said channel is rectilinear. The end body 1 represents a flange with a neck, while the end body 2 is an OU seat holder. The end body 1, representing a flange with a neck, has a smooth bearing surface 6' for OU securing, while the end body 2 has a smooth seat 6' for OU securing too. The three bodies 1, 2, 3 are hard, the interstitial body 3 representing a housing of the device embracing the whole end body 2. The interstitial body 3 has attachment surfaces 7, 7' for mounting of the device respectively to a socket or a console of an apparatus. The body 3 has also a seat for securing of an additional OU (AOA), the seat being disposed coaxially to but outside the two connected OA. The end body 1, representing a flange with a neck, is axially connected to the interstitial body 3 by a plain hinge, while the end body 2 and the interstitial body 3 are frontally connected in a common slip plane transversal to their axes. Besides, the hinge contact surfaces are a part of a concave cylinder and a base of a parallelepiped 11. The concave contact cylindrical surface 10 belongs to the end body 1 hinged to the interstitial body 3, and has a central axis 0'-0' crossing the symmetry

axis of the interstitial body 3 placed therein. The central axis 0'-0' of the hinge is disposed within the volume of the interstitial body 3, while the end body 2 and the interstitial body 3, frontally connected in the slip plane, have each a contact plane 15 transversal to the axes thereof. Each movable body 1, 2 of the triad is connected to the neighbouring body and locked, when adjusting the OA, by the same coupling and locking screws 4, 5 fitting the kind of the body/s adjustment shifts. The screws 4, 5 are arranged in groups and placed in the interstitial body 3, the number of screws being the same or different, whereat the screws 4 for transversal rectilinear shifts are subjected to compression, while the screws 5 for angular shifts are subjected to tension. The screws 4 are disposed along axes perpendicular to the axes of both the interstitial body 3 and the end body 2 frontally connected therewith, while the screws 5 are disposed along axes parallel to the axes of both the interstitial body 3 they are placed in and the end body 2. Besides, the axes of the screws 4, 5 are, in pairs, mutually crossing and/or perpendicularly intersecting. The embodiment as per Fig. 7 does not contain any indication of the full number of the screws 4 and 5, but just a pair thereof. The coupling and locking screws 4, 5 are adjusting as well. The three bodies 1, 2, 3 are, in pairs, axially tightened by coupling and locking screws 5 and 4, that is why the rectilinear or angular adjustment shifts are independent of each other.

An eighth embodiment of the device according to the invention is shown in Fig. 8. Here, the device comprises a triad of two end OU carriers 1, 2 and an interstitial body 3, connected and locked by coupling and locking screws 4 and 5,

thus forming an optical channel isolated from or communicating with the environment. The channel has heterogeneous optical medium, determined by the presence of an additional OU placed between the two OU being connected. The three bodies 1, 2, 3 have opposite central through holes shaping the opening of the optical channel. The axis of the said channel is rectilinear. The two end bodies 1, 2 represent flanges with bilaterally projecting necks along the central axes of the bodies 1, 2. The bodies 1, 2 have smooth bearing surfaces 6" for OA. The three bodies 1, 2, 3 are hard, the interstitial body 3 representing a housing of the device with a U-shaped profile. The base of the interstitial body 3 has an attachment surface 7' for the device to be mounted to a panel, seat or console of an apparatus. Besides, it has also a bearing surface 16 for the additional OU (AOA), the latter being disposed between the OU being adjusted and along the axis of the optical channel. The additional OU renders the medium of the optical channel heterogeneous. The end body 1 is externally and axially connected to one of the walls of the interstitial body 3 by a spatial or plain hinge, while the end body 2 is externally and frontally connected to the other wall of the interstitial body 3 in a common slip plane transverse to the axes of their through holes. Besides, the hinge contact surfaces are either a part of a concave sphere 8 and a base of a right circular cylinder 9, or a part of a concave cylinder 10 and a base of a parallelepiped 11 or a cube 12, or a part of a concave ellipsoid 13 and a base of an elliptic cylinder 14. Each of the concave hinge surfaces 8, 10, 13 belongs to the interstitial body 3 and has a center 0 on the symmetry axis of the end body 1 hinged therein, or has a central axis 0'-0'

crossing the said axis of symmetry. The center 0 and the central axis 0'-0' of the respective concave contact surfaces 8, 10, 13 of the respective hinge are disposed within the volume of the hinged end body 1, while the end body 2 and the interstitial body 3, frontally connected in the slip plane, have each a contact plane transverse to the axes thereof. Each movable body 1, 2 of the triad is connected to the neighbouring interstitial body 3 and locked, when effecting OU adjustment, by the same coupling and locking screws 4, 5 fitting the kind of the movable body/s adjustment shifts. The screws are arranged in groups and situated in the interstitial body 3, the number thereof being the same or different, whereat the screws 4 for transverse rectilinear adjustment are subjected to compression, while the screws 5 for angular adjustment are subjected to tension. The screws 4 are disposed along axes perpendicular to the axes of both the interstitial body 3 they are placed in and the end body 2 frontally connected therewith, while the screws 5 are disposed along axes parallel to the axis of the interstitial body 3 they are placed in. Besides, the axes of the screws 4, 5 are, in pairs, mutually crossing and/or perpendicularly intersecting. The embodiment in Fig. 8 does not indicate the full number of the screws 4 and 5, but just a pair thereof. The coupling and locking screws 4, 5 are adjusting as well. In addition to the screws 4 and 5, Fig. 8 contains an indication of screws 4' that ensure a fit for the frontal slipping of the end body 2 along the interstitial body 3 in the case of transversal adjustment. The construction according to Fig. 8 makes it possible to effect transverse and angular adjustments, independently of each

other, by tightening of the respective screws 4, 5 following a number of stepwise shifts of the movable bodies 2 and 1.

A **ninth embodiment** of the device according to the invention is shown in Fig. 9. Here, the device comprises five triads of two end bodies 1, 2 and one interstitial body 3 each, said bodies being connected and locked by screws 4, 5 forming an optical channel, the latter being isolated from or communicating with the environment. The three bodies 1, 2, 3 of each triad have opposite central through holes forming the opening of the optical channel within the area of those bodies. The end body 2 is common for all the triads of bodies 1, 2, 3, and represents a housing of the device, one of the OU being common too and situated in the center of the housing as a movable reflector or a light source. The optical channel axis is respectively angularly refracted or branched from a common point. The other end body 1 of each triad of bodies 1, 2, 3 represents a flange with a neck and has a smooth bearing surface 6' for the OA. The base of the end body 2, representing a housing, has an attachment surface 7' intended for mounting to a panel or a holder. The three bodies 1, 2, 3 of each triad are hard, the movable body 1 being axially connected to the interstitial body 3 by a spatial or plain hinge, while the end body 2 and the interstitial body 3 are frontally connected in a slip plane transverse to the axes thereof. Besides, the hinge contact surfaces are either a part of a concave sphere 8 and a base of a right circular cylinder 9, or a part of a concave cylinder 10 and a base of a parallelepiped 11 or a cube 12, or a part of a concave ellipsoid 13 and a base of an elliptic cylinder 14. Each of the concave contact surfaces 8, 10, 13 of the hinge belongs to the movable end body 1 and has

a center 0 on the symmetry axis of the end body 2 placed therein, or has a central axis 0'-0' crossing the said symmetry axis. The center 0 and the central axis 0'-0' of the respective concave contact surfaces 8, 10, 13 of the hinge are situated within the volume of the interstitial body 3, while the ~~movable~~ end body ~~1~~ and the interstitial body 3, frontally connected in the slip plane, have each a contact plane 15 transverse to the axes thereof. Each movable body 1, 2 of each triad is connected to the neighbouring body and locked, when performing OU adjustment, by the same coupling and locking screws 4 and 5, fitting the kind of the OU adjustment shifts. The screws 4, 5 are arranged in groups of the same or different number of screws and placed in the immovable end body 2, whereat the screws 4 for transverse rectilinear displacement are subjected to compression, while the screws 5 for angular displacement are subjected to tension. The screws 4 are disposed along axes perpendicular to the axes of both the interstitial body 3 and the end body 2 frontally connected therewith, while the screws 5 are disposed along axes parallel to the axes of both the interstitial body 3 and the end body 2 situated therein. Besides, the axes of the screws 4, 5 are, in pairs, mutually crossing and/or perpendicularly intersecting. The embodiment in Fig. 9 does not contain any indication of ~~the full number of the screws 4 and 5, but just a pair thereof.~~ The coupling and locking screws 4, 5 are adjusting at the same time. The results of the axial tightening of all contact surfaces as shown in Fig. 9, respectively the sealing of the optical channel, as well as those of the overall adjustment of the device by a number of stepwise tightening of said screws 4 and 5, are the same as the results according to the embodiment

in Fig. 1. The bodies 1, 2, 3 of each triad are axially tightened together by the screws 5 for angular displacement of movable bodies.

A tenth embodiment of the device according to the invention is shown in Fig. 10. Here, the device comprises a triad of hard bodies, i.e. two OU carriers 1, 2 and an interstitial body 3 connected and locked by coupling and locking screws 4 and 5, thus forming an optical channel communicating with the environment. The end body 1 and the interstitial body 3 have opposite central through holes forming the opening of the optical channel, whose axis is rectilinear. The end body 1 has a smooth bearing surface 6' for the OA. The end body 2 is dense and is made of two parts assembled by means of threading, i.e. a flange 2' and a table 2" with a smooth bearing surface 6' for the reflecting OA. The table 2" closes one of the openings of the through hole of the interstitial body 3. The body 3 consists of two axially connected parts, i.e. an immovable part 3' and a rotationally movable self-locking part 3", the two parts being hinged with each other. The immovable part 3' represents a housing of the device and has an attachment surface 7 for mounting to a board, a panel, or a holder. Besides, the immovable part 3' has a seat with the end body 1 with the through hole being situated therein, while the movable part 3" has a seat with the table 2" of the end body 2 being placed therein, so that the flange 2' of the end body 2 remains outside the through hole of the movable part 3". The end body 2 is axially connected to the movable part 3" of the interstitial body 3 by means of a spatial hinge, while the end body 1 is frontally connected to the immovable part 3' of the interstitial body 3 in a common

slip plane transversal to their axes. Besides, the hinge contact surfaces are either a part of a concave sphere 8 and a base of a right circular cylinder 9, or a part of a concave ellipsoid 13 and a base of an elliptic cylinder 14. Each of the hinge concave contact surfaces 8 and 13 belongs to the movable part 3" of the interstitial body 3 and has a center 0 on the symmetry axis of the end body 2 hinged therein. The center 0 of the respective concave contact surface 8, 13 of the respective hinge is situated within the volume of the hinged movable part 3" of the interstitial body 3 and the table 2" of the end body 2. The end body 1 and the immovable part 3' of the interstitial body 3, frontally connected in the slip plane, have each a contact plane 15 transverse to the axes thereof. Each movable body 1, 2 of the triad is connected to the neighbouring body and is independently locked, when effecting OU adjustment, by coupling and locking screws 4, 5 fitting the kind of OU displacement. The screws 4, 5 are arranged in groups of the same or different number of screws respectively in the immovable part 3' of the interstitial body 3 and in the flange 2' of the end body 2, whereat the screws 4, 5 of the respective groups for transverse rectilinear and angular OU displacement are subjected to compression only. The screws 4 are disposed along axes perpendicular to the axes of both the interstitial body 3 and the end body 1 frontally connected therewith, while the screws 5 are disposed along axes parallel only to the axis of the end body 2 they are situated in. Besides, the axes of the screws 4, 5 are, in pairs, mutually crossing and/or perpendicularly intersecting. The embodiment in Fig. 10 contains no indication of the full number of the screws 4 and 5, but just a pair thereof. The

coupling and locking screws 4, 5 are adjusting as well. The three bodies 1, 2, 3 are, in pairs, axially tightened together by the coupling and locking screws 4, 5.

Information Sources

1. Specifications of SU Inventor's Certificate No. SU1723550A1

2. Specifications of SU Inventor's Certificate No. 883838

3. Specification of Canadian Patent - (A) No. 1258786